



## **Railway Education Programs at the Technical University of Denmark and Other European Universities, and Related Careers**

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# Railway Education Programs at the Technical University of Denmark and Other European Universities, and Related Careers

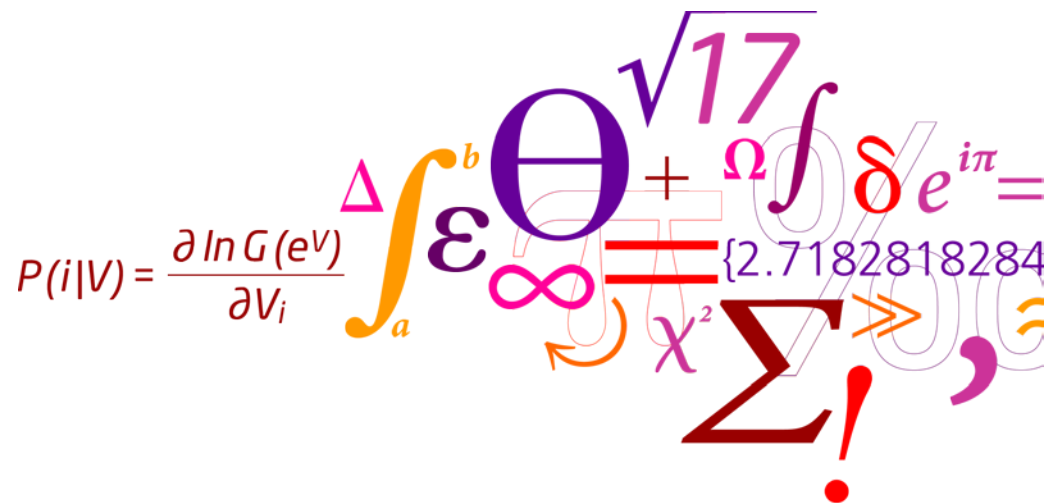
INFORMS 2017, Houston

Steven Harrod

Associate Professor

DTU Management Engineering

**RAILTECH DTU**



# Railway Careers and Education

- Career Trends
  - More professional management
  - More value in data analysis across job titles
- Education Programs
- DTU Program in Detail
  - Degrees
  - Courses
  - Research focus
  - Challenges



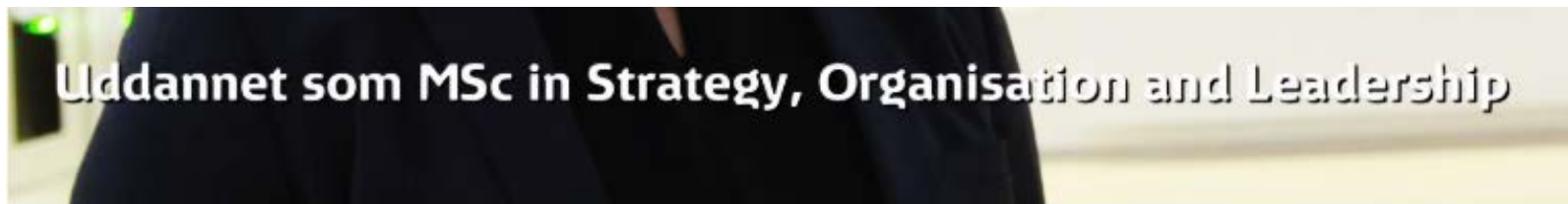
# Traditional Railway Career

- Start in train service (brakeman, station operator)
- Promotion by experience
  - Engineer, then foreman, then superintendent
  - Dispatcher, then traffic manager, then director
- Top executives frequently filled from legal and finance
  - Regulated environment
  - Operations not a source of innovation

# 21<sup>st</sup> Century Shift in Career Preparation



“Educated with a Master of Science in Strategy, Organization, and Leadership”



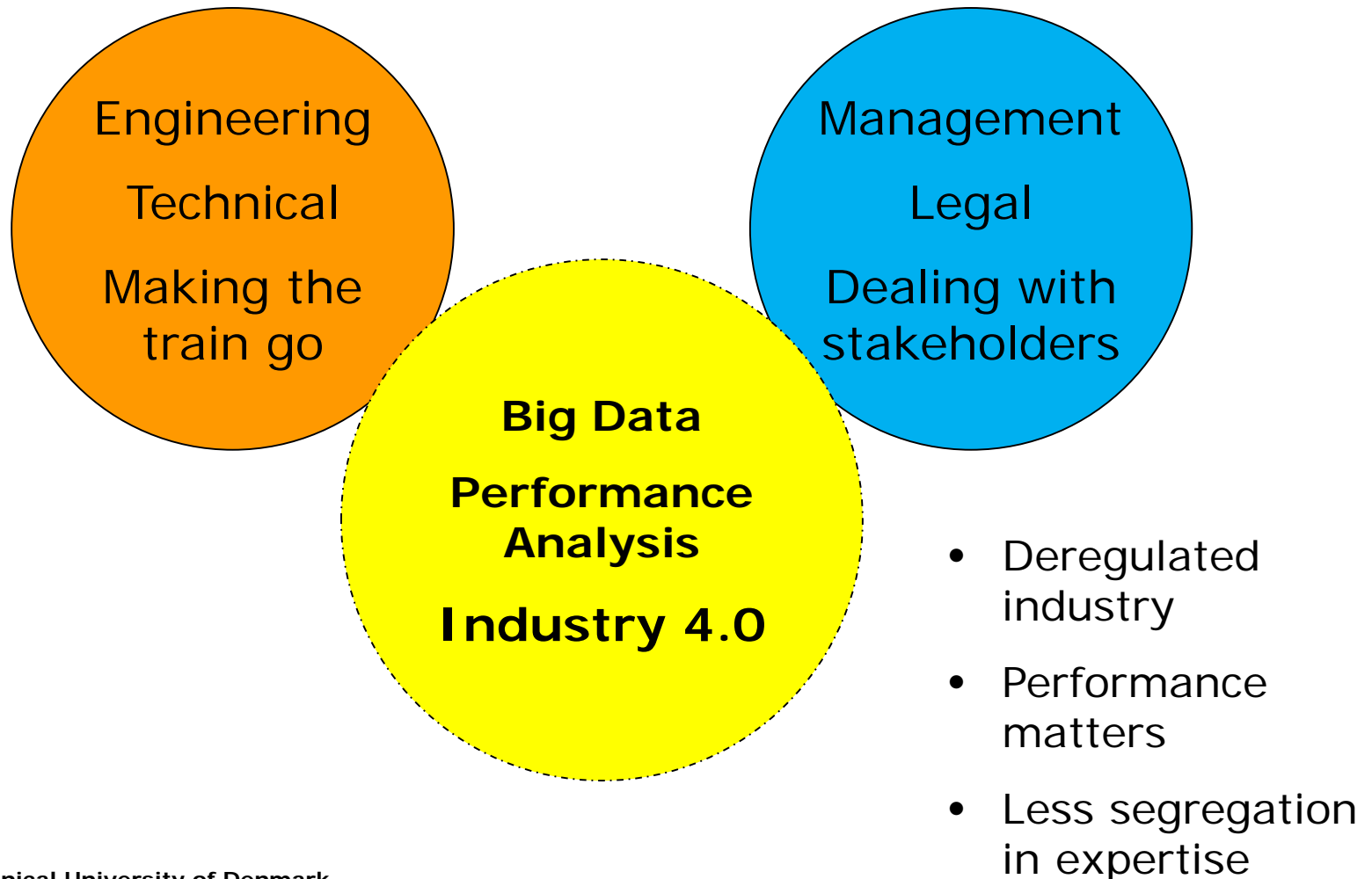
# Education/Career Matches at Norfolk Southern

## Note

- "Operations" vs. "non-operations"
- Multiple listing and importance of INFORMS skills

NS OPERATIONS DEPARTMENTS		PREFERRED MAJORS												
		Electrical Engineering	Civil Engineering	Computer Engineering	Mechanical Engineering	Industrial Engineering	Metallurgical Engineering	Construction Engineering	Materials Science	Construction Management	Geographic Information Sciences (GIS)	Supply Chain	Logistics	Business Management
Communication	Creative, persuasive, and effective communication skills to generate ideas													
Design & Construction	Design and construction of complex business infrastructure													
Maintenance	Maintenance of positions and infrastructure in Norfolk, Va.													
Network & Service	Network and service management													
Research	Research and development													
Transportation	Transportation management													
NS NON-OPERATIONS DEPARTMENTS		PREFERRED MAJORS												
		Business	Accounting	Civil Engineering	Industrial Engineering	Computer Science	Information Technology	Marketing	MBA	Economics	Supply Chain	Logistics		
Accounting Operations		✓	✓											
Industrial Development				✓										
Industrial Engineering					✓									
Information Technology						✓	✓							
Audit & Compliance		✓	✓											
Marketing		✓						✓	✓	✓	✓	✓	✓	✓
Revenue Accounting & Customer Service (RACS)		✓	✓					✓	✓	✓	✓	✓	✓	✓
Sourcing		✓									✓	✓	✓	✓
Operations Research					✓	✓								
Labor Relations		✓						✓	✓	✓	✓	✓	✓	✓

# Transportation Bodies of Knowledge












# Subject Coverage from “Railway” Schools

University Name	Mechanical Eng.	Electrical Eng.	Civil Eng.	General Eng.	Operations Res.	Operations Mgt.	Transport Models	Marketing and Service	Strategy and Leadership
Beijing Jiaotong University					X	X	X	X	X
Colorado State University - Pueblo				X					
Delft University of Technology			X		X		X		
KTH Royal Institute of Technology	X	X	X	X					
Michigan Technological University	X	X	X	X		X			X
Norwegian University of Science and Technology			X						
University of Belgrade	X	X	X		X		X	X	X
University of Birmingham	X	X	X	X		X	X		X
University of Illinois at Urbana-Champaign			X	X	X		X		
University of Leeds							X	X	
Penn State Altoona			X				X		X
Technical University of Denmark			X		X	X	X		
Sapienza, University of Rome			X		X		X		
University of South Carolina	X	X	X	X		X			X
University of Southampton	X		X				X		

# Railway Education at DTU

## Domestic and International

- Diplomingeniør 
- MSc 
  - Railway study line
  - Other education
    - Flexible master
    - Open education
- PhD 

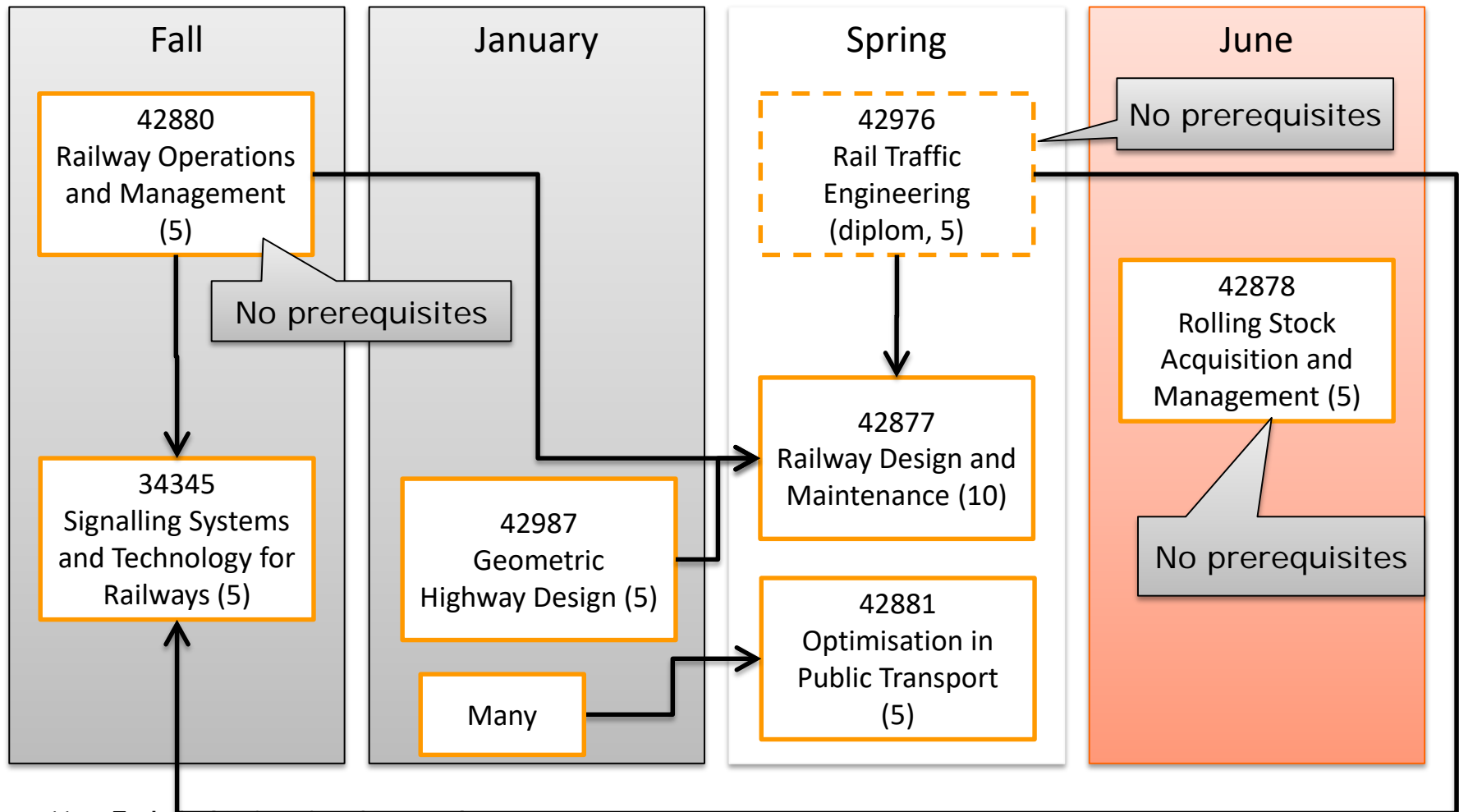




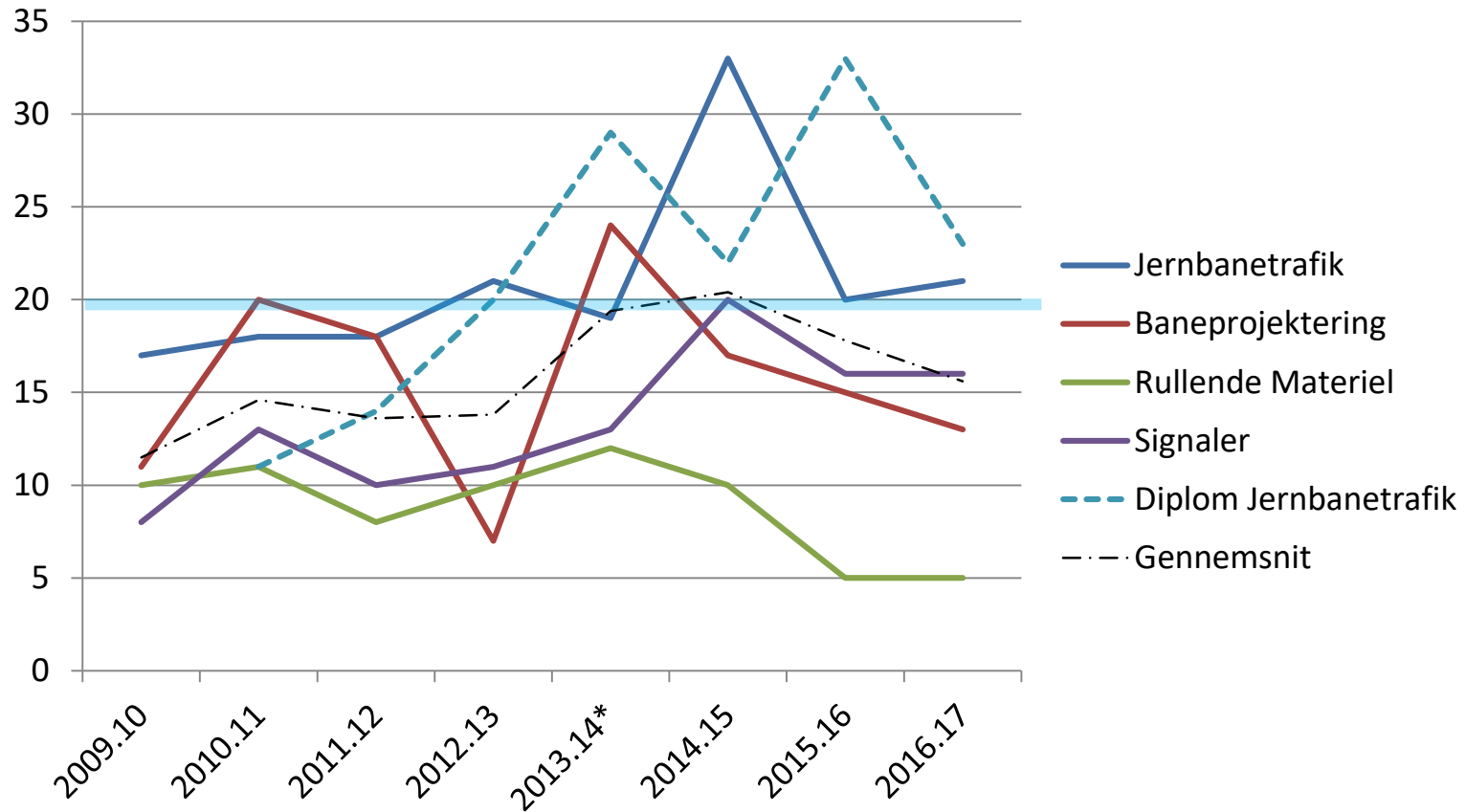
# Railway Courses All in English for 2017

- MSc
  - 42880 Railway Operations and Management
  - 42878 Future Trains: Railway Fleet Acquisition and Management
  - 42877 Railway Design and Maintenance
  - 34345 Signaling Systems and Technology for Railways
  - 42881 Optimisation in Public Transport
- Diplom or bachelor
  - 42976 Rail Traffic Engineering

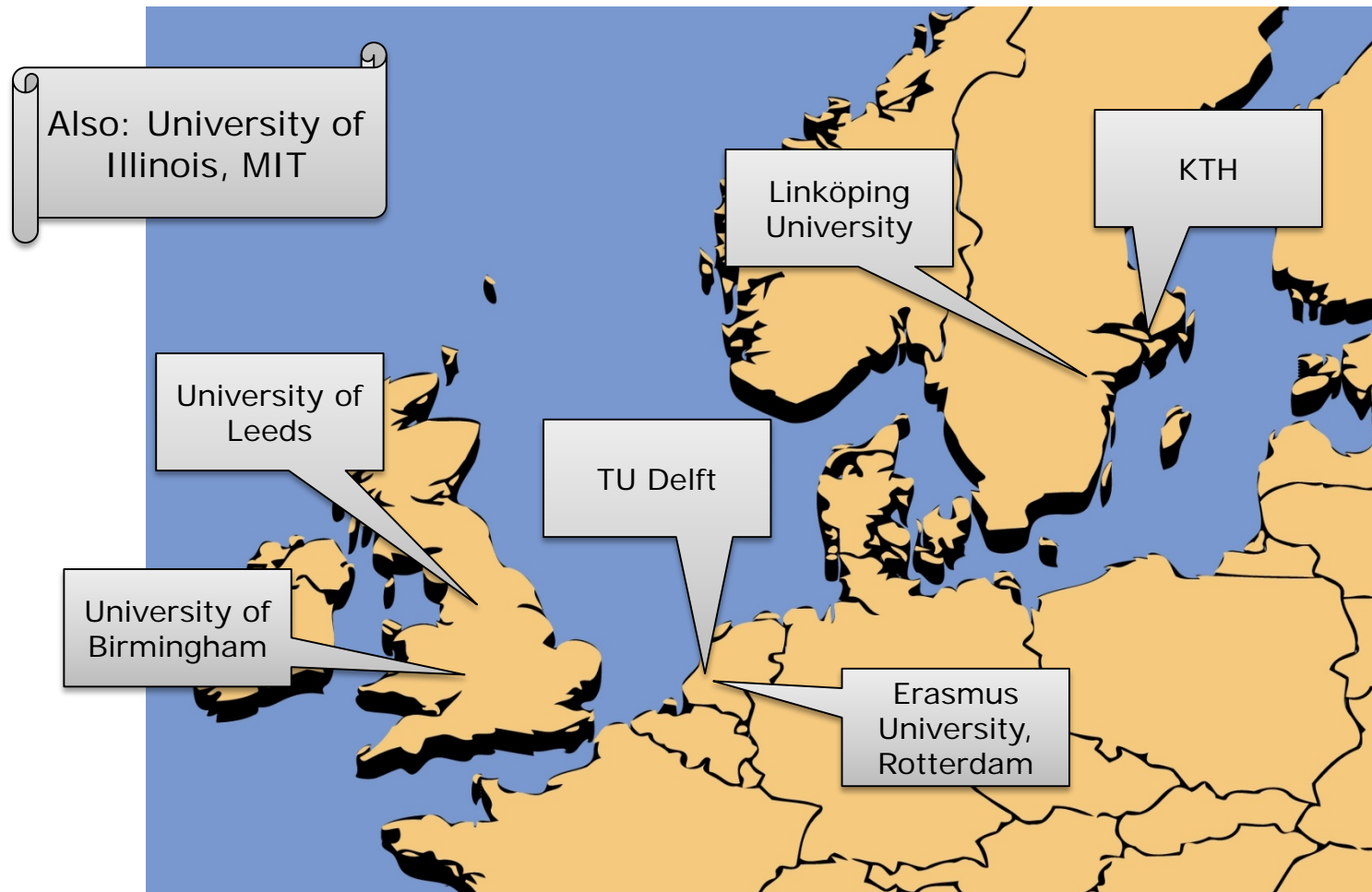
# Courses have few prerequisites but are spread throughout academic year



# Kursustilmelding

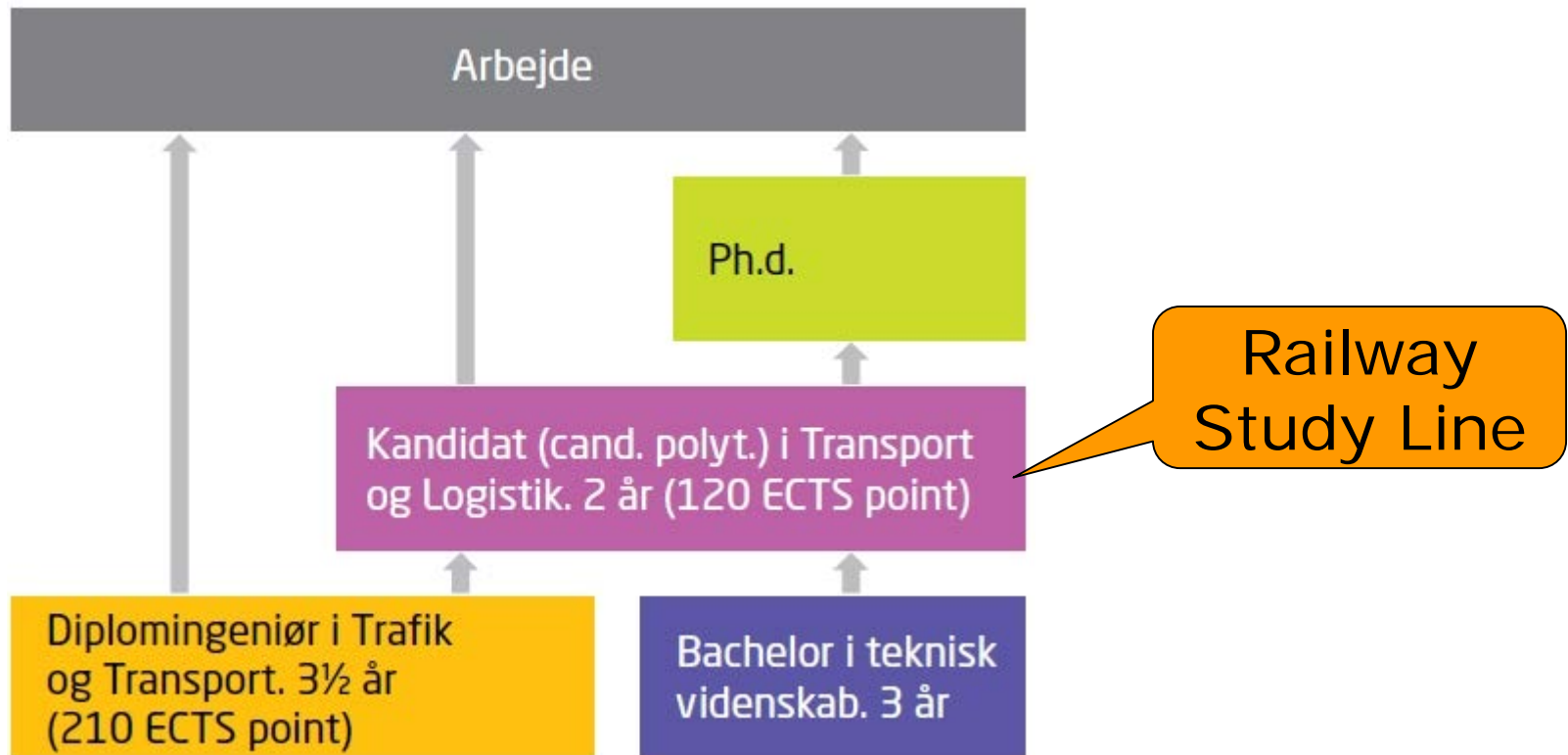


# Partners and Peer Institutions



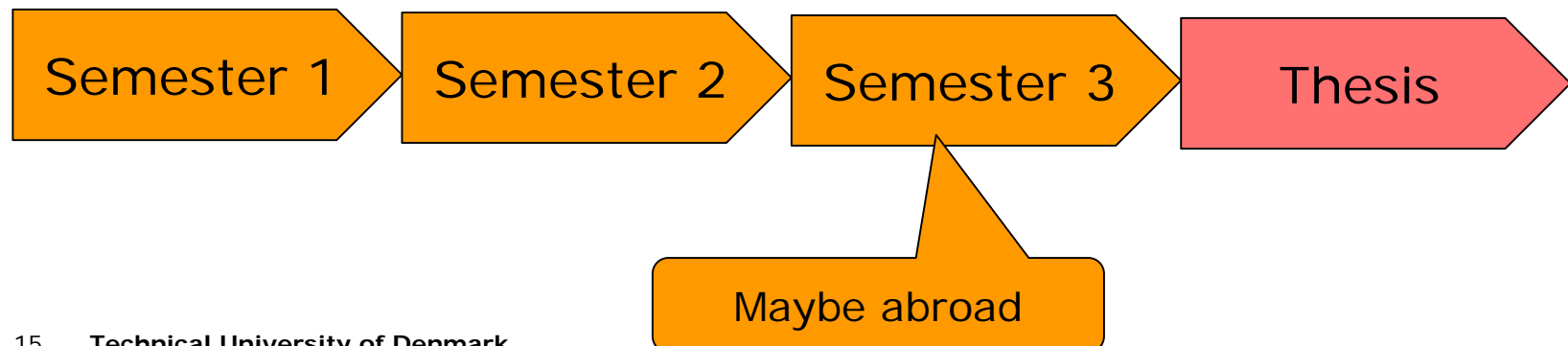


# On the Way to a Career



# Master of Science Sequence

MSc program – 120 ECTS points	
General Degree Competences (min. 30 points)	Technological Specialisation (min. 30 points)
Elective Courses (max. 30 points)	Thesis (30 / 32.5 / 35 points)



# 42878: Rolling Stock Acquisition and Management

“Wagons, coaches, and locomotives.”

“Quality transportation.”

- Technology

- Body structure
- Motive power
- Braking and control

- Service Design

- Product design
- Design for reliability

- Purchasing

- Contracts
- Selection

- Maintenance

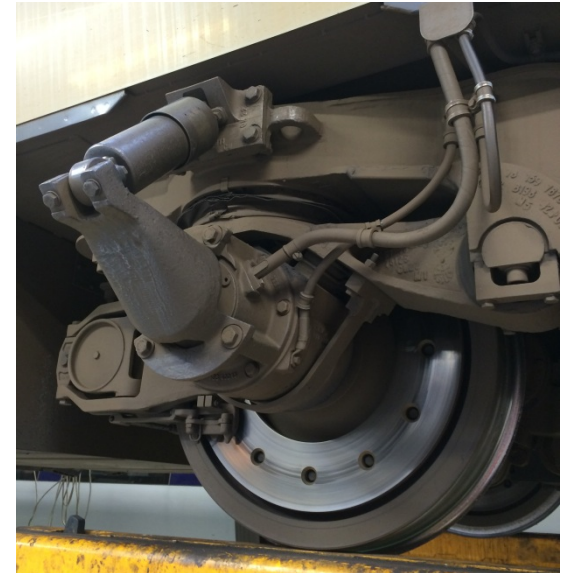
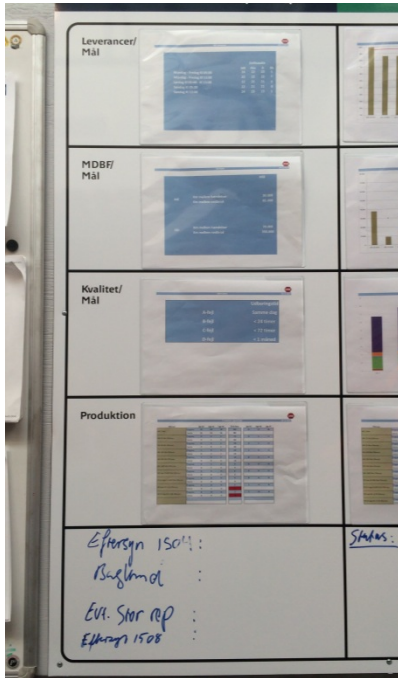
- Processes
- Quality management

Providing Value to the Customer

# How to manage these facilities?



# There is a Lot of Technology



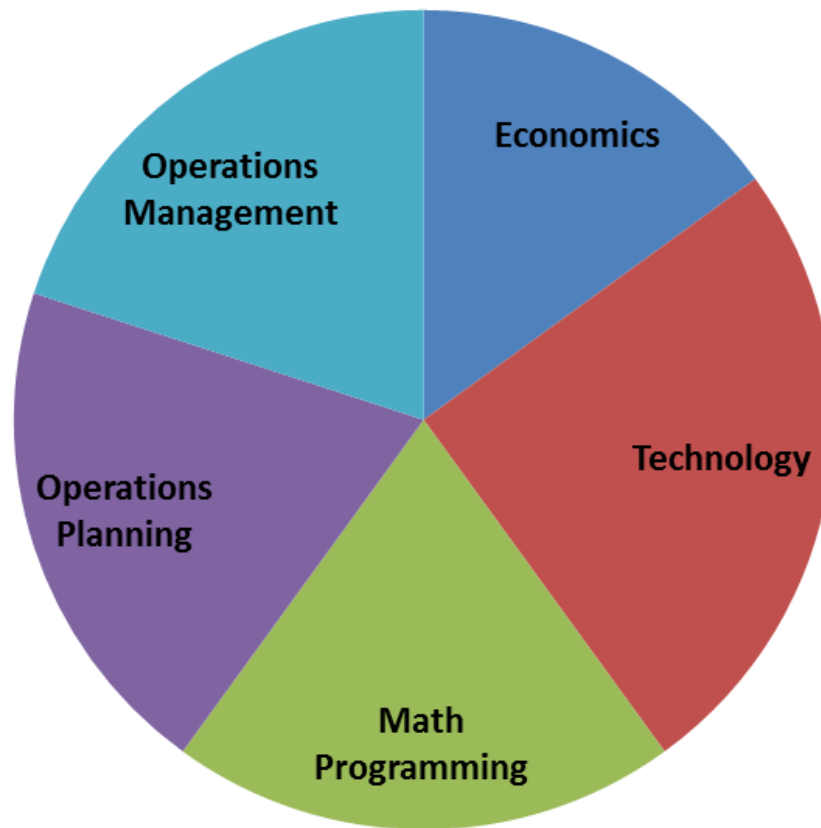
# 42880: Railway Operations and Management

- General Competence
- Survey Course
  - Broad topic coverage
  - Introductory level
  - Railway as a business
  - Railway planning
  - Railway operations
  - Railway technology





# Topic Distribution



# Much More Focus on Management

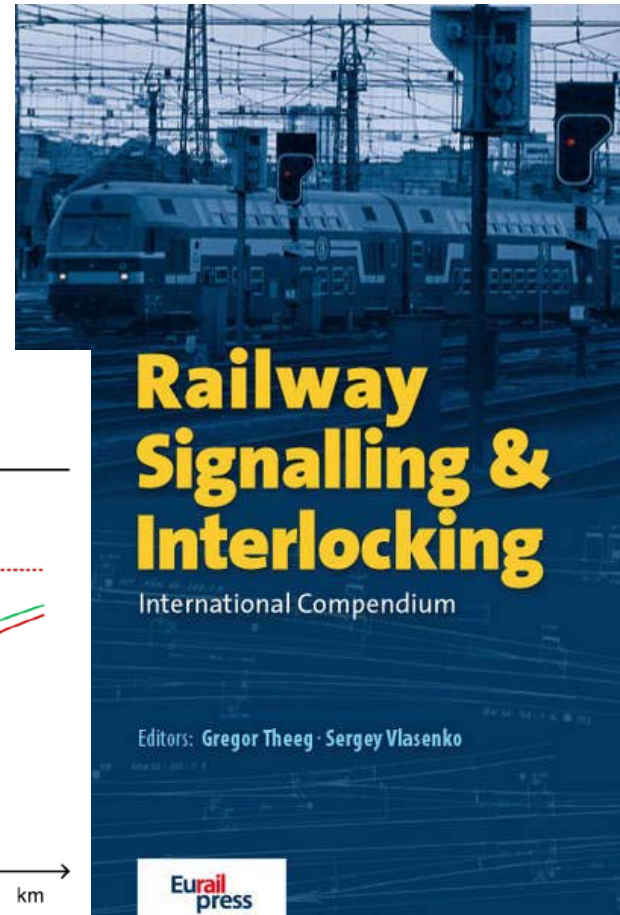
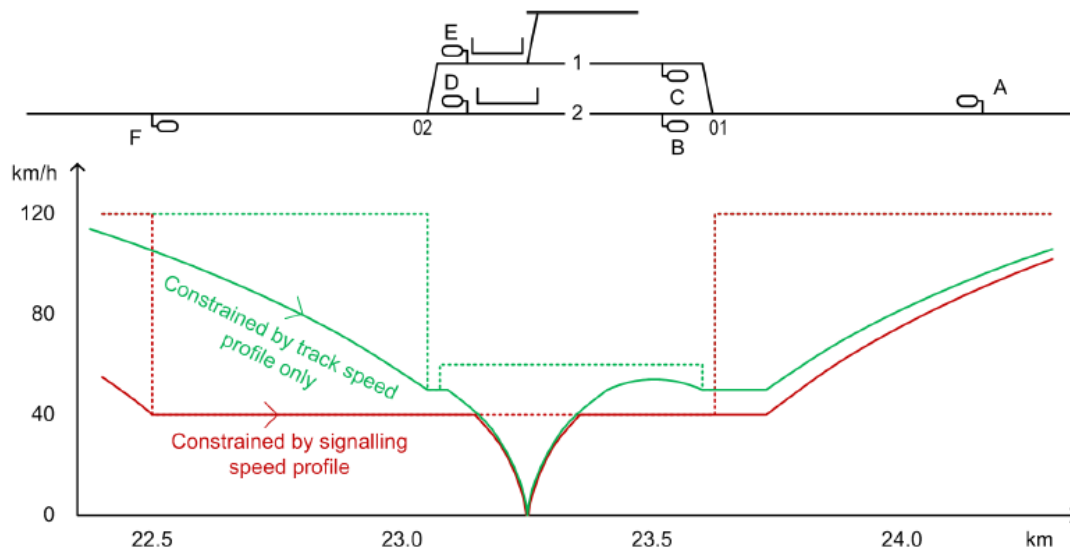
- Market demand and finances
- Some overlap with jernbanetrafikteknik, but topics are covered very quickly
- New content on mathematical optimization and stochastic processes

# 34345: Signaling Systems and Technology for Railways

- Signaling technology
- Modern signal system design
- Safety standards
- Advanced wireless signals

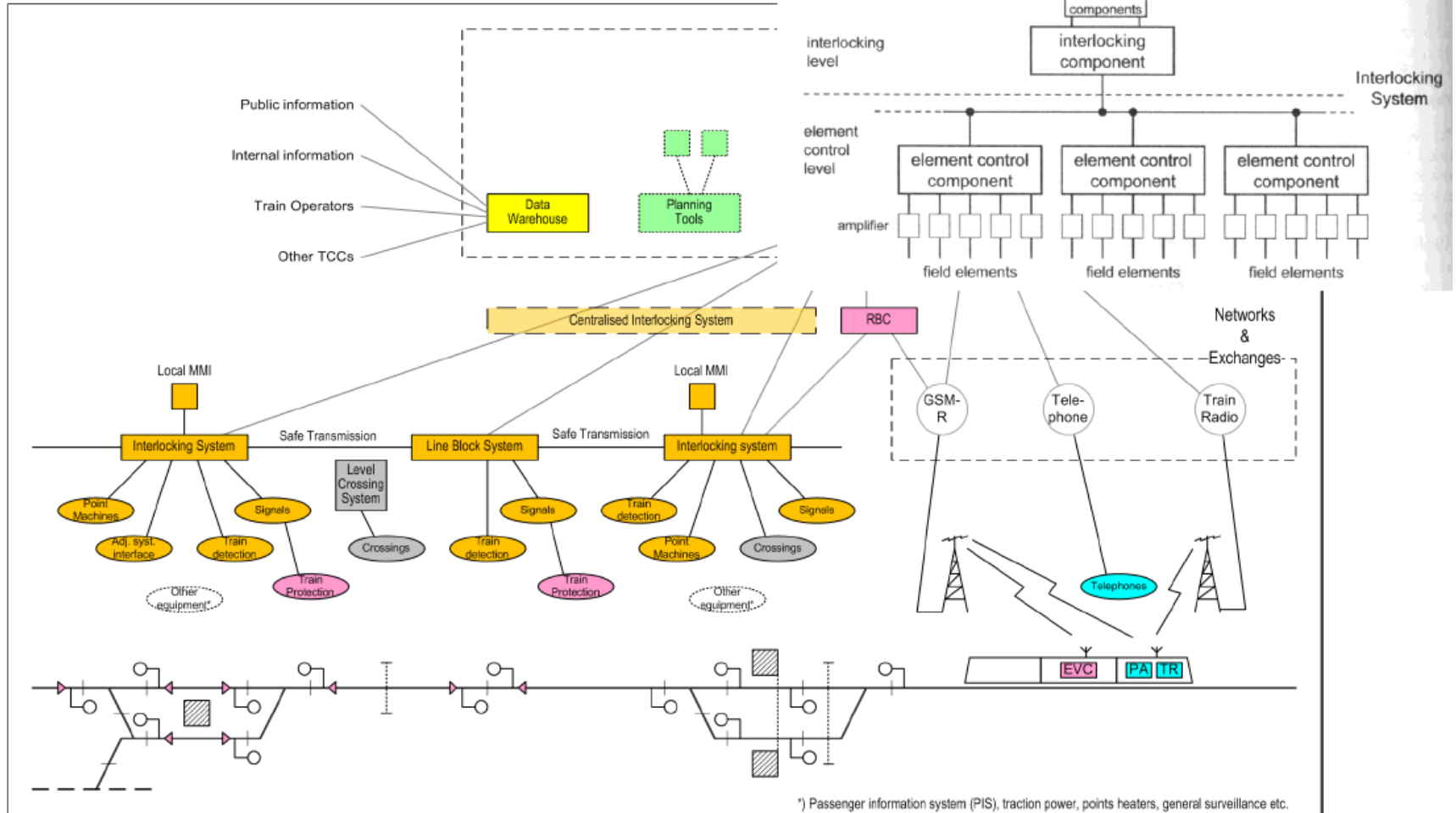


# Advanced Analysis of Signal Effects on Operations



# Electronic interlocking systems

## System architecture



Være med!

# Prospects for Growing Enrollment

- More international recruiting
- Better presentation of career opportunities
- More tours and industry outreach
  - Innotrans
  - Hamburg
  - Danish rail facilities



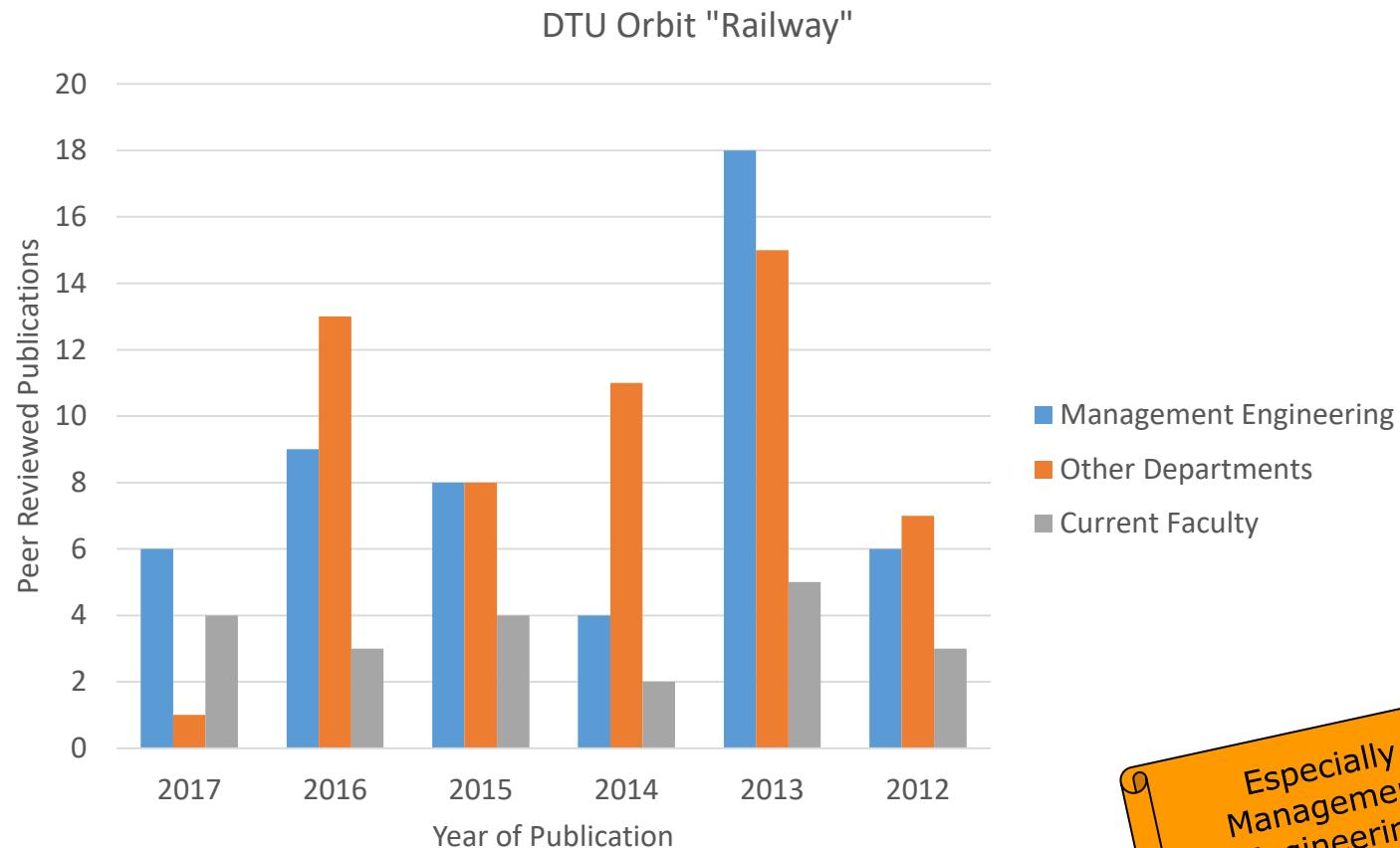
# Tour to Innotrans Received High Evaluations from Students



Bombardier



# DTU Has a Rich Railway Research Output



Especially  
Management  
Engineering

# MSc Theses in 2014-15

- Signalanlæg til letbaner
- Retningslinjer for strategisk vedligeholdelsesplanlægning
- Analyse af jernbanegodstransport i Danmark
- Vurdering af lokaltog til containertransport i Danmark
- Analyse og håndtering af trafikforstyrrelser på jernbanen

# MSc Theses 2016-

- Kontinuert overvågning af køreledningsanlæg
- Analyse af sammenhæng mellem forsinkelser på danske jernbaner
- Costbenefit analyse af sporautomatiseringsvedligeholdelse
- Undersøgelse af slab track på danske jernbaner
- Operationelle statistiske analyser af de nye kørselstidspunkter. København Metro Case
- En delvis integration af linjeplanlægning og køreplanlægning
- Spordesign af S-togsforbindelse mellem Farum og Hillerød
- Risikoanalyse og Beslutningsstøtte: Et case vedr. introduktionen af CBTC-Systemet på S-Togsbanen)
- Bæredygtig Transportvurdering og Stakeholderanalyse: Et case eksempel med anvendelse af stokastisk simulering på komparative vurderinger

# Web Visibility Search “Railway Master of Science”

## Denmark

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About 17.000.000 results (0,53 seconds)

### [Transport and Logistics \(MSc\) - DTU](#)

[www.dtu.dk/english/Education/msc/Programmes/transport\\_and\\_logistics](http://www.dtu.dk/english/Education/msc/Programmes/transport_and_logistics) ▼

The MSc programme in Transport and Logistics is designed to give you all the ... as logistics combined with skills in software technology, data science, planning methods, ... Railway Management and Engineering gives you the opportunity to ...

### [KTH | Master's programme in Railway Engineering](#)

<https://www.kth.se/.../master/railway.../master-s-programme-in-railway-engineering-1....> ▼

May 17, 2017 - Railway transport is experiencing a worldwide renaissance. It offers substantial economic, energy efficiency, environmental and safety benefits ...

### [Railway Infrastructure, M.Eng. - Part time online by ... - Masters Portal](#)

[www.mastersportal.eu/studies/62949/railway-infrastructure.html](http://www.mastersportal.eu/studies/62949/railway-infrastructure.html) ▼

Study a Masters of Engineering Railway Infrastructure, developed exclusively for engineers employed in the rail industry to advance your professional practice. ... Developed as a cooperative project between the rail industry and the Queensland University of Technology, this course ...

Sat, 1 Jul [Railway Infrastructure, M.Eng.](#)

### [MSc in Rail and Logistics - NewRail - Newcastle University](#)

[www.ncl.ac.uk](http://www.ncl.ac.uk) › [NewRail](#) › [Study With Us](#) ▼

Feb 15, 2017 - The objective of the programme is to develop your ability to initiate and carry out advanced performance systems analysis and research ...

## Kentucky

[All](#) [News](#) [Images](#) [Maps](#) [Videos](#) [More](#) ▼ [Search tools](#)

About 15,700,000 results (0.50 seconds)

### [Railway Systems Engineering and Integration Masters/MSc/Diploma ...](#)

[www.birmingham.ac.uk](http://www.birmingham.ac.uk) › ... › [Postgraduate taught degrees](#) ▼ | [University of Birmingham](#) ▼

The taught postgraduate programme in Railway Systems Engineering and Integration has a strong focus on developing postgraduates' railway engineering knowledge and know-how, their systems integration skills and their understanding of the complex interactions between subsystems.

### [Advanced Masters in Rail and Urban Transport Systems | École des ...](#)

[www.enpc.fr/en/node/8474](http://www.enpc.fr/en/node/8474) ▼ | [École des ponts ParisTech](#) ▼

The rapid growth in the railway sector has prompted constructors and operators to turn to the grandes Ecoles to create a high-level educational programme ...

### [Delft University of Technology: Road and Railway Engineering - TU Delft](#)

[www.tudelft.nl/.../master-of-science/master.../msc.../ro...](http://www.tudelft.nl/.../master-of-science/master.../msc.../ro...) ▼ | [Delft University of Technology](#) ▼

Read here how international students and alumni have experienced the MSc ... Infrastructural facilities such as roads, airfields, port areas, railways and ...

### [Official Master's Degree in Railway Systems - 13th Year \(7th Year as ...](#)

[www.icae.upcomillas.es/en/master/msf-en](http://www.icae.upcomillas.es/en/master/msf-en) ▼ | [ICA School of Engineering](#) ▼

For information on the Master's Degree in Railway Systems, contact: +34 91 ... in Industrial Engineering or similar, as well those who hold degrees in sciences.

### [Railway Systems Engineering and Integration Masters/MSc/Diploma ...](#)

<https://www.findamasters.com/.../masters-degree/.../railway-systems-engineering-and-i...> ▼ |

Railway Systems Engineering and Integration Masters/MSc/Diploma/Certificate ... an appropriate

# Ideas for Program Promotion

- More outreach to gymnasia students
- More opportunities for exchange students
  - Within Danish universities
  - From international markets
- More alignment with hiring and career opportunities at rail firms
- Better central information source



# Summary

- INFORMS topics increasingly relevant to railway careers
- Still a heavy engineering focus in self described “railway” schools
- DTU making a transition to balanced OR/MS and engineering program
- Still needs to grow its program to sustainable numbers

# Thank you and “vi ses”

